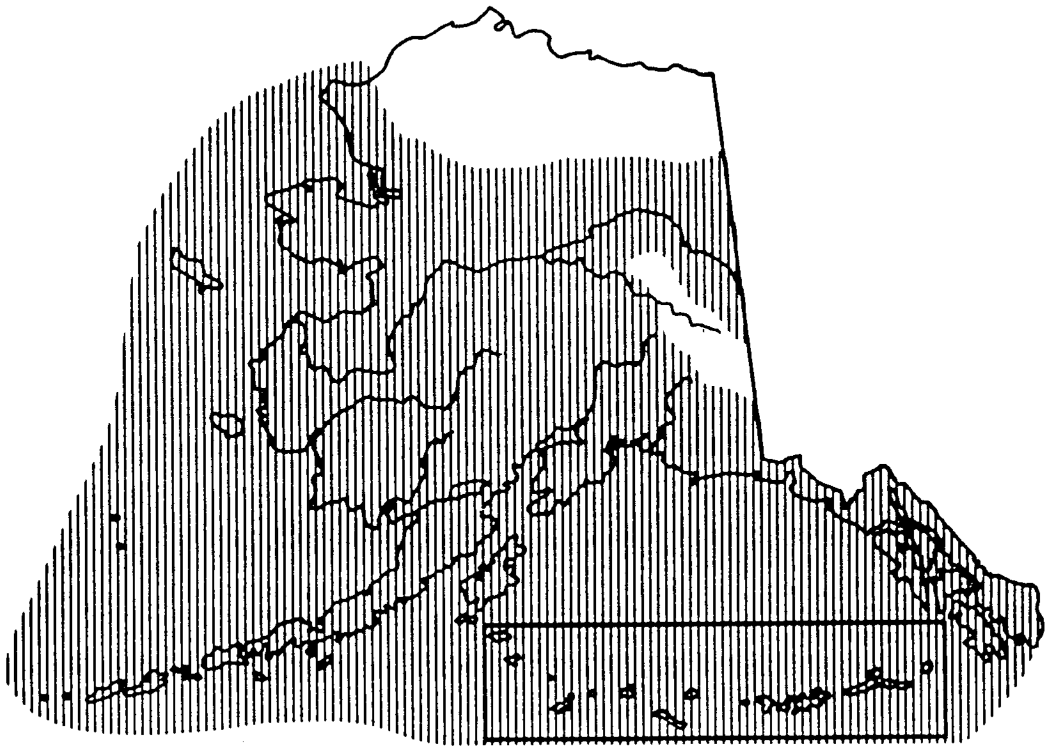
Coho Salmon Life History and Habitat Requirements
Southwest, Southcentral, Arctic, Western, and Interior Regions



Map 1. Range of coho salmon (ADF&G 1978, Morrow 1980)

I. NAME
   A. Common Names: Coho salmon, coho, silver salmon, sea trout
   B. Scientific Name: Oncorhynchus kisutch
   C. Native Names: See appendix A.

II. RANGE
   A. Worldwide
      The coho salmon occurs naturally in the Pacific Ocean and its drainages. In North America, it is found from Monterey Bay, California, north to Point Hope, Alaska. In Asia, it occurs from the Anadyr River in northeastern Siberia south to Hokkaido, Japan (Scott and Crossman 1973).
   B. Statewide
      In Alaska, coho salmon are abundant from Dixon Entrance (Southeast Alaska) north to the Yukon River. Evidence suggests that coho

salmon are rare north of Norton Sound (ADF&G 1977) although ADF&G documents them as far north as Kuchiak Creek, which is located northeast of Cape Lisburne and immediately south of Kasegaluk Lagoon.

C. Regional Distribution Maps

To supplement the distribution information presented in the text, a series of blue-lined reference maps has been prepared for each region. In this series, coho salmon distribution information is included on the 1:250,000-scale maps titled Distribution of Anadromous Fish. These maps are available for review in ADF&G offices of the region or may be purchased from the contract vendor responsible for their reproduction. In addition, a set of colored 1:1,000,000-scale index maps of selected fish and wildlife species has been prepared and may be found in the Atlas that accompanies each regional guide.

D. Regional Distribution Summary

1. Southwest. In the Kodiak area, many streams have runs of coho salmon; however, the runs are late in the season, and escapement figures are incomplete (ibid.).

   In the Bristol Bay area (for waters from Cape Newenham to Cape Menshikof and northside Alaska Peninsula streams south to Cape Sarichef), major coho salmon-producing drainages include the Togiak and Nushagak systems, with smaller runs found in the Kulukak, Naknek, Kvichak, Egegik, and Ugashik systems (Middleton 1983). Further south on the Alaska Peninsula, important north-side coho salmon-producing systems are found at Nelson Lagoon, Port Heiden, and Cinder River. Smaller fisheries also exist at Swanson Lagoon and Ilnik (Shaul, pers. comm.).

   For south-side Alaska Peninsula streams and the Aleutian Islands, data are scarce concerning coho salmon production. The best known runs on the South Peninsula occur in Russel Creek, Mortensen Lagoon, and Thin Point Cove at Cold Bay (ADF&G 1977a). A few streams on Unalaska Island and several small drainages in the Aleutian Islands contain coho salmon, but the size of the run is unknown (Holmes, pers. comm.). It is known that the Chignik River system produces most of the coho salmon utilized by the commercial fishery in the Chignik area. Other streams in the Chignik area also contain coho salmon, although the size of the runs is not known (ADF&G 1977a). (For more detailed narrative information, see volume 1 of the Alaska Habitat Management Guide for the Southwest Region.)

2. Southcentral. In the Upper Cook Inlet area, major coho salmon spawning and rearing drainages include the Susitna, Kenai, and Kasilof river systems (McLean et al. 1977a). In the Lower Cook Inlet area, coho salmon are found in the English Bay lakes system, Clearwater Slough, and the Douglas, Big Kamishak, Little Kamishak, and McNeil river systems (ADF&G 1983b). In the Prince William Sound area, coho salmon

are the dominant species in the Bering River (ADF&G 1978a). They are also found in numbers in the Copper and Katalla river drainages (ADF&G 1978a, 1983c). (For more detailed narrative information, see volume 2 of the Alaska Habitat Management Guide for the Southcentral Region.)

3. Arctic. In the Norton Sound District, coho salmon have been documented in 19 first-order streams (those with mouths at salt water) (ADF&G 1984). Although not the only significant coho salmon-producing systems, the Unalakleet River drainage and the Shaktoolik River are considered to be the most important coho salmon producers in the district (Schwarz, pers. comm.).

   Within the Port Clarence District, coho salmon have been documented in the Agiapuk and Kuzitrin first-order river systems (ibid.).

   Within the Kotzebue District, first-order systems known to sustain populations of coho salmon include the Buckland, Noatak, Wulik, and Kivalina rivers (ibid.).

   Coho salmon are documented in only one stream in the Northern District: Kuchiak Creek, northeast of Cape Lisbourne (ibid.). (For more detailed narrative information, see volume 2 of the Alaska Habitat Management Guide for the Arctic Region.)

4. Western. Both the Kuskokwim and Yukon rivers traverse the Western Region and serve as migration corridors for coho salmon. Known Western Region coho salmon-producing waters of the Kuskowim River system (i.e., those tributaries located downstream of and including the Holitna River drainage) include the Kwethluk, Aniak, Salmon (Aniak River tributary), Kipchuk, Oskawalik, and Kogrukluk rivers (ADF&G 1977c, 1978b). Coho salmon are also found in the Eek, Kisaralik, Tuluksak, Hoholitna, and Cheeneetnuk river systems of the Kuskokwim drainage (ADF&G 1983d). Within that portion of the Yukon River drainage found in the Western Region (i.e., tributaries downstream of the village of the village Paimuit), coho salmon are documented in the Andreafsky and Chuilnak rivers (ADF&G 1985). Other coho salmon-producing systems in the region include the Arolik, Goodnews, and Kanektok rivers (ADF&G 1978b). Sixteen first-order streams (those whose mouths are at salt water) on Nunivak Island are also documented as having coho salmon present (ADF&G 1985a). (For more detailed narrative information, see volume 2 of the Alaska Habitat Management Guide for the Western and Interior Regions.)

5. Interior. The Kuskokwim and Yukon rivers serve as pathways for coho salmon bound for spawning areas in the Interior Region. Known coho salmon-producing waters of the Kuskokwim River system in the Interior Region (i.e., those tributaries upstream of the Holitna River drainage) extend to the North, East, and South Forks of the Kuskokwim River and include the

Salmon (tributary of Pitka Fork of the Middle Fork Kuskokwim River), Tatlawiksuk, Nixon Fork (tributary of the Tokotna River), and Gagaryah rivers (ADG&G 1983d). Within the Yukon River drainage of the Interior Region (i.e., those tributaries upstream of the village of Paimuit), coho salmon are documented in 10 second-order streams (those whose mouths are at the Yukon River). They include the Innoko, Bonanza, Anvik, Tanana, Hodzana, Porcupine, Kandik, and Tatonduk rivers and Birch and Beaver slough/creeks (ADF&G 1985b). Their presence has also been documented in the Tozitna River (Barton, pers. comm.). The major coho salmon spawning areas documented to date occur in the tributaries of the upper Tanana River drainage (ADF&G 1983e). (For more detailed narrative information, see volume 2 of the Alaska Habitat Management Guide for the Western and Interior Regions.)

III. PHYSICAL HABITAT REQUIREMENTS

A. Aquatic

1. Water quality:

a. Temperature. Egg incubation and alevin development have occurred over a wide range of temperatures. Reiser and Bjornn (1979) list recommended incubation temperatures for coho salmon as 4.4 to 13.3°C.

Under laboratory conditions, Brett (1952) found the upper lethal temperature limit of juvenile coho salmon from British Columbia to be 25.0°C. Reiser and Bjornn (1979) list preferred temperatures for rearing juveniles as 11.8 to 14.6°C. Bustard and Narver (1975), during winter studies on a small stream in Vancouver, British Columbia, found that at 7°C or less the young coho were associated with water velocities of less than 15 cm/sec. They also noted that as water temperature decreased from 9 to 2°C the coho salmon moved closer to cover (e.g., logs, uprooted tree roots, debris accumulations, overhanging banks, and overhanging brush).

While feeding in the ocean, maturing coho salmon have been found in areas where surface temperatures have ranged from 4.0 to 15.2°C, with most being found in the 8 to 12°C range. Various evidence, however, indicates that coho may occur in even colder waters (Godfrey 1965).

Adult entry into fresh water may be triggered in part by a rise in water temperature (Morrow 1980). Spawning occurs over a wide range of water temperatures. Godfrey (1965) cites Gribanov, who reported water temperatures during spawning in Kamchatka, USSR, rivers as low as 0.8°C and as high as 7.7°C. Reiser and Bjornn (1979) suggest that 4.4 to 9.4°C is a more preferred temperature range for spawning.

b. The pH factor. There is no optimum pH value for fish in general; however, in waters where good fish fauna occur, the pH usually ranges between 6.7 and 8.3 (Bell 1973). State of Alaska water quality criteria for freshwater growth and propagation of fish specify pH values of not less than 6.5 or greater than 9.0, with variances of no more than 0.5 pH unit from natural conditions (ADEC 1979).

c. Dissolved oxygen (D.O.). The groundwater that is typical of coho salmon spawning beds is usually highly oxygenated (Godfrey 1965).

   Davis et al. (1963), during laboratory tests of sustained swimming speeds of juvenile coho salmon, found that the reduction of oxygen concentration from air saturation levels to 7, 6, 5, 4, and 3 mg/l usually resulted in reduction of the maximum sustained swimming speed by about 5, 8, 13, 20, and 30%, respectively.

   Adult swimming performance is also adversely affected by reduction of D.O. concentrations below air saturation level. Bell (1973) states that it is desirable that D.O. concentrations be at or near saturation and that it is especially important in spawning areas, where D.O. levels must not be below 7 ppm at any time. State of Alaska water quality criteria for growth and propagation of fish state that "D.O. shall be greater than 7 mg/l in waters used by anadromous and resident fish. Further, in no case shall D.O. be less than 5 mg/l to a depth of 20 cm in the interstitial waters of gravel utilized by anadromous or resident fish for spawning. . . . In no case shall D.O. above 17 mg/l be permitted. The concentration of total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection."

d. Turbidity. Sedimentation causes high mortality to eggs and alevin by reducing water interchange in the redd. If 15 to 20% of the intragravel spaces become filled with sediment, salmonid eggs have suffered significant (upwards of 85%) mortality (Bell 1973). Prolonged exposure to turbid water causes gill irritation in juveniles, which can result in fungal and pathogenic bacterial infection. Excess turbidity from organic materials in the process of oxidation may reduce oxygen below safe levels, and sedimentation may smother food organisms and reduce primary productivity (ibid.). From investigation of the Susitna River in Southcentral Alaska during 1982, turbid water was found to be a strong factor that influenced juvenile fish distributions. This study indicates that rearing coho salmon apparently avoid turbid water (ADF&G 1983a). Turbid water will absorb more solar radiation than clear water and may thus indirectly raise thermal barriers to adult upstream spawning migration (Reiser and Bjornn 1979).

2. Water quanitity:

   a. Instream flow. Sufficient water velocity and depth are needed to allow proper intragravel water movement (apparent velocity) so that dissolved oxygen is transported to eggs and alevins and in turn metabolic wastes are removed (ibid.).

      Juveniles after emerging from the gravel stay almost entirely in pools, avoiding riffle areas (Morrow 1980). Burger et al. (1983), during studies on the Kenai River, Alaska, and its tributaries, found that recently emerged juveniles (less than 50 mm long) in the main stem of the river were close to banks and often in reaches where the river had flooded terrestrial areas. Most of these juveniles were found in zones of zero water velocity, and almost 80% were captured in areas of less than 6.1 cm/sec mean water column velocity. Larger juvenile coho salmon (51 to 71 mm) were typically captured in creek mouth basins, backwater pools, and man-made canals. Ninety percent of these fish were in habitat having no measurable water velocity. In contrast to these findings, the juveniles in Kenai River tributary streams were found in pool-riffle habitat. Burger et al. (1983) suggest that sooner-emerging chinook salmon juveniles may be displacing main stem spawned coho salmon into tributaries, canals, and basins. He also suggests that since the main stem age 0 coho salmon do not appear to be attaining the same growth as similar age fish in the Deshka or Susitna rivers, the areas to which they have been forced is probably not their preferred habitat and may not supply the drift food items that are a major contributor to salmonid diets. Competition with stickleback may also play a role in the lower coho salmon growth rates.

      Bovee (1978) suggests that an optimum water velocity for coho salmon fry is from 15.2 to 18.3 cm/sec.

      Stream water velocity is important to juveniles because it is the most important parameter in determining the distribution of aquatic invertebrates (food sources) in streams (Reiser and Bjornn 1979).

      Excess velocities and shallow water may impede migrating fish. Thompson (1972) indicates that Pacific Northwest coho salmon require a minimum depth of 0.18 m, with velocities less than 2.44 m/sec. for migration. No measurements of Alaska waters for adult migration criteria are available.

      Velocity is also important in redd construction because the water carries dislodged substrate materials from the nesting site. Measured flow rates at 0.12 m above the streambed include 19.2 to 69.2 cm/sec in Oregon and 7.6 to 61.0 cm/sec in the Columbia River and tributaries (Smith 1973). Minimum water depths at these spawning sites ranged from 0.122 to 0.153 m in Oregon and from 0.305 to 0.458 m in the Columbia River and tributaries. Smith (1973) recommended that the spawning velocity (as measured 0.12 m above streambed) and minimum depth criteria for Oregon coho salmon be 21.0 to 70.0 cm/sec and 0.15 m, respectively. Burger et al. (1983) lists measured velocities for the Kenai River and one tributary stream as 21.4 to 30.5 cm/sec pit velocity and 51.8 to 82.8 cm/sec tailspill velocity (measurement taken at 0.6 total depth). The pit depths at these redds were 54.5 to 76.3 cm, and the tailspill depths were 25.0 to 45.0 cm.

3. Substrate. Egg incubation and alevin development occur in substrates ranging widely in size and composition. The ADF&G (1977) states that optimum substrate composition is small-to-medium gravel. Generally, sediments less than .64 cm diameter should comprise less than 20 to 25% of the incubation substrate (Reiser and Bjornn 1979).
   Substrate composition regulates production of invertebrates, which are food sources for juveniles. Highest invertebrate production is from gravel and rubble-size materials associated with riffle areas (ibid.).

B. Terrestrial

1. Conditions providing security from predators or other disturbances. Emergent terrestrial vegetation was the dominant cover type used by rearing juvenile coho salmon in their backwater pool-rearing areas in the main stem Kenai River (Burger et al. 1983). Undercut banks and deep water pools provide protection for adults.
2. Conditions providing protection from natural elements. Bustard and Narver (1975), working in Vancouver, British Columbia, noted that the juvenile coho salmon were associated with water velocities of less than 15 cm/sec when the water temperature was 7°C or less. They also noted that as the temperature dropped from 9 to 2°C young coho salmon moved closer to cover provided by such things as logs, uprooted trees, debris accumulations, overhanging banks, and overhanging brush.

IV. NUTRITIONAL REQUIREMENTS

A. Food Species Used

Upon hatching, young alevin remain in the gravel for two or three weeks until the yolk sack has been absorbed. Following emergence from the gravel, the juveniles begin feeding at or near the surface (Morrow 1980). Major food items at this time are terrestrial insects, especially species of flies (Diptera) and wasps and bees (Hymenoptera), and perhaps also aphids and thrips (ibid.). Burger et al. (1983) found that midges (chironomids) were dominant in stomach samples of juvenile coho salmon in the Kenai River, Alaska. Juvenile coho salmon food habit studies during August and September in sloughs and clearwater tributaries of the middle reach of the Susitna River suggest that the range and diversity of invertebrates in their diet indicate an ability to adapt to variable conditions (ADF&G 1982). Specimens collected during the study had consumed both terrestrial and aquatic invertebrates. Based on numbers consumed, they relied mainly on midge (Diptera: Chironomidae) larvae, pupae, and adults. Although not contributing much in terms of dry weight, the major components of their terrestiral diet were usually small aphids (Homoptera: Aphidae), small Depterans (Phoridae, Simuliidae, and Scaridae), and small (less than 5 mm) Hymenopterans (ibid). The diet can also include mites, beetles, springtails (Collembola), spiders, and small zooplankton. As the young fish grow they consume larger food items and often consume young sockeye salmon. In Chignik Lake, Alaska, young coho salmon have been found to eat seven times as many juvenile sockeye salmon as do Dolly Varden, and in other localities coho salmon may be equally serious predators (Morrow 1980). Scott and Crossman (1973) state that large numbers of chum and pink salmon are also taken by coho salmon.

Upon entering the sea, young coho salmon feed on various planktonic crustaceans, pink and chum salmon fry, herring, sand lance, other fishes, and squid (ibid.).

The food of marine adults is more pelagic and more varied than that of many Pacific salmon. Fishes make up 70 to 80% of the coho salmon's food, invertebrates 20 to 30%, and include the following: pilchard, herring, anchovy, coho salmon, capelin, lanternfish, Pacific saury, hake, whiting, rockfishes, black cod, sculpins, sand lance, squid, barnacles, isopods, amphipods, euphausiids, crab larvae, and jelly fish (Morrow 1980, Scott and Crossman 1973). Herring and sand lance make up 75% of the volume (Pritchard and Tester 1944). Some populations, however, remain on the crustacean diet, such coho generally not growing as big as those that eat fish (Prakash and Milne 1958).

B. Types of Feeding Areas Used

Young juveniles feed in low-velocity areas along streambanks and in backwater pools and current eddies. Feeding is generally near the surface, with drifting invertebrates the prey; young coho salmon feed infrequently on bottom-dwelling organisms (Morrow 1980). As they grow in size, the juveniles may become serious predators of other small fish, including other salmon species.

When the young coho salmon migrate to the sea, they tend to stay fairly close to shore at first. The oceanic movements of coho salmon in the southern part of the range (i.e., Washington, Oregon, British Columbia) seem to be chiefly along the coast, with some fish apparently never venturing far from the coast. By contrast, northern fish, particularly those from Alaskan streams, spread out all across the North Pacific and into the Bering Sea (ibid.). Available evidence from commercial fisheries and research vessels indicates that while at sea coho salmon occur most frequently near the surface. Individuals have been taken at greater depths, but most coho salmon have been caught in the upper 10 m (Godfrey 1965).

C. Factors Limiting Availability of Food

Sedimentation is one of the major factors affecting freshwater food availability. Excessive sedimentation may inhibit production of aquatic plants and invertebrate fauna (Hall and McKay 1983). Bell (1973) states that primary food production is lowered above levels of 25 JTU (Jackson Turbidity Unit) and visual references lost above levels of 30 JTU.

D. Feeding Behavior

Food varies from place to place and with time (Scott and Crossman 1973). While on the high seas, schools may become involved in a feeding frenzy and have been found to be eating blue lanternfish and sauries (Hart 1973). Upon entering fresh water, adult salmon no longer feed but live off the fat they stored up while in the ocean (Netboy 1974).

V. REPRODUCTIVE CHARACTERISTICS

A. Reproductive Habitat

Short coastal streams are usually preferred, but coho salmon are known to spawn in spring-fed tributaries of the Yukon River drainage from the Bonasila River at least as far upstream as the Fishing Branch River in the headwawters of the Porcupine River system (Barton, pers. comm.). Although spawning may occur in main channels of large rivers, locations at the head of riffles in shallow tributaries or narrow side channels are preferred (ADF&G 1977). Vining et al. (1985), from chum salmon incubation studies of main stem, triburary, side channel, and slough habitats within the middle reach of the Susitna River, Alaska, caution that, because of the effects of dewatering and freezing, the amount of available habitat at the time when adult salmon are spawning is a poor indicator of the amount of actual habitat that is available as potential incubation habitat. Estimates of available incubation habitat must take into account the differential effects of dewatering and freezing in various habitat types.

B. Reproductive Seasonality

In Alaska, coho salmon enter freshwater streams from mid July through November (Russell, pers. comm.). Actual spawning generally occurs between September and January (ADF&G 1977). In the Norton Sound area, coho salmon spawn during late August (Lean, pers. comm.). As a rule, fish in the northern part of the range enter fresh water earlier in the season, with runs occurring progressively later to the south (Morrow 1980).

C. Reproductive Behavior

As with other salmon, adult coho salmon return from the sea and move into their natal freshwater streams to spawn. The female selects the spawning site and digs the redd (nest) by turning on her side and thrashing her tail up and down. The current washes loosened substrate material downstream, and a depression 8 to 51 cm (average about 20 to 25 cm) deep is formed in the river bottom (Burner 1951, Morrow 1980). Eggs and sperm (milt) are released simultaneously and deposited in the redd. After egg deposition, the female moves to the upstream margin of the redd and repeats the digging process. Dislodged substrate is washed over the eggs. In this manner, the eggs are covered and prevented from washing away. The process is repeated many times, and the redd appears to move upstream (Burner 1951). As a result of the continued digging, the redd may grow to become 1.2 m^2 to 6.6 m^2, with a general average of about 2.8 m^2 for Columbia River basin redds (ibid.). A female may dig several redds and spawn with more than one male (McPhail and Lindsey 1970).

D. Age at Sexual Maturity

The age at which coho salmon reach sexual maturity ranges from two to six years, although most usually return from marine waters to spawn at ages 3 or 4. The number of four-and five-year-old fish usually increases northward (Scott and Crossman 1973).

E. Fecundity

The number of eggs varies with the size of the fish, the stock, and sometimes the year. Numbers have been reported from 1,440 to 5,770; the average probably lies between 2,500 and 3,000 (Morrow 1980). Godfrey (1965) cites studies of Kamchatkan (Russian) salmon, where the average number of eggs was 4,883.

F. Frequency of Breeding

As with all Pacific salmon, the spawning cycle is terminal. Both male and female die after spawning.

G. Incubation Period/Emergence

The amount of time required for eggs to hatch is dependent upon many interrelated factors, including 1) dissolved oxygen, 2) water temperature, 3) apparent velocity in gravel, 4) biological oxygen demand, 5) substrate size (limited by percentage of small fine material), 6) channel gradient and 7) configuration, 8) water depth, 9) surface water discharge and velocity, 10) permeability, 11) porosity, and 12) light (Reiser 1979, Hart 1973). Generally speaking, factors 4 through 12 influence or regulate the key factors 1, 2, and 3.

In Alaska, hatching usually takes place from mid winter to early spring, the amount of time varying with the water temperature. Scott and Crossman (1973) indicate that hatching times have ranged from 38 days at 10.7°C to 48 days at 8.9° in California, and they postulate that it might take 42 to 56 days farther north. Morrow (1980) states that incubation takes six to nine weeks and may require as long as five months. After hatching, the alevin remain in the gravel for 2 to 3 weeks (some may take up to 10 weeks) and emerge from the gravel sometime from April to June (ADF&G 1978 Morrow 1980, Godfrey 1965).

VI. MOVEMENTS ASSOCIATED WITH LIFE FUNCTIONS

A. Size of Use Areas

Juvenile coho salmon after emerging from the gravel take up residence not far from redds, especially near the banks, where they tend to congregate in schools. As they grow they disperse and become aggressive and territorial. Laboratory experiments by Chapman (1962) show that juveniles are aggressive and territorial or hierarchical in behavior. Hierarchies and territories were organized on the basis of fish size, and smaller fish tended to move downstream because of the continuous harassment by the larger fish. Stein et al. (1972) support these findings and from their laboratory experiments with Sixes River, Oregon, stocks found that rearing coho salmon were more aggressive than chinook salmon, tolerated fewer individuals of their own species than did chinook salmon, and defended positions at the upstream end of a riffle where drifting food organisms were first available to fish.

From studies of Columbia River tributaries, Burner (1951) suggests that a conservative figure for the number of pairs of salmon that can satisfactorily utilize a given area of spawning gravel may be obtained by dividing the area by four times the average size of the redds. Redd area can be computed by measuring the total length of the redd (upper edge of pit to lower edge of tailspill) and the average of several equidistant widths (Reiser and Bjornn 1979). Burner (1951) states that Columbia River basin coho salmon redds averaged 2.8 m^2. Burger et al. (1983) measured three redds (two in the Kenai River main stem, one in a tributary stream) and listed their sizes. Main stem redds were 1.5 and 0.9 m long x 1.2 and 0.6 m wide, respectively. The tributary redd was 1.8 m long x 1.0 m wide.

B. Timing of Movements and Use of Areas

The young coho salmon normally spend a year in fresh water before going to sea, although some may go to sea at the end of their first summer. Others, as in the Karluk River on Kodiak Island, Alaska, may stay two, three, or even four years in fresh water (Morrow 1980). Middleton (1983) states that in Bristol Bay streams coho juveniles stay in fresh water mainly two or more years. The same is said for the Chignik and Nelson Lagoon systems by Shaul (pers. comm.), who postulates that most coho salmon on the Alaska Peninsula probably spend two winters in fresh water. In the Taku River of Southeast Alaska, downstream movement of juveniles bound for the sea is usually at night (Meehan and Siniff 1962), and the trip is completed during the period mid April through mid June. Studies of smolt out-migration in the Bear Lake system, near Seward, indicate that very few smolts migrate prior to stream temperatures attaining 3.9°C (Logan 1967), and for this system the seaward movement of natural stocks commences during mid May and continues through late September, with 50% of the migration passing the sampling weir by mid June (Logan 1967, 1968, 1969). Burger et al. (1983) suggest that the Kenai River seaward migration occurs probably from July to November. More detailed run timing information for different stocks is presented in the salmon distribution and abundance narratives found in this report series.

Having spent two or three years in the ocean, mature coho salmon first arrive in appreciable numbers in coastal waters of central and southeastern Alaska early in July, and the runs extend into August or September (Morrow 1980, Godfrey 1965). Alaska Peninsula coho salmon spend only one year in salt water (Shaul, pers. comm.). Returns of western Alaskan stocks begin in late July in the Kuskokwim and Yukon rivers and extend through August (ADF&G 1977c). Returning adult coho salmon are found in the bays and estuaries of Norton Sound from early to mid August (ibid.).

Adult upstream migration and intensive entry into a river is associated with the beginning of a rising tide, whereas schooling off the mouth of a river, in brackish waters, occurs during the period of the falling tide (Gribanov 1948). They ascend the rivers during both rising and falling water levels but cease movement during peak floods (ibid.). When in the river, they move upstream mainly during daylight hours (Neave 1943).

C. Migration Routes

Rivers and streams serve as corridors for smolt out-migration. Barriers to adult upstream movement include excess turbidity, high temperatures (20.0°C or more), sustained high-water velocities (greater than 2.44 m/sec), and blockage of streams (log jams, waterfalls) (Reiser and Bjornn 1979).

Results of seining and tagging operations have demonstrated that juvenile North American coho salmon make extensive migrations. Alaskan coho salmon enter the Alaskan gyre (a generally counter-clockwise flow of water moving westerly near the south side of the Alaska Peninsula and Aleutian Islands) and travel "downstream," making one complete circuit per year (Morrow 1980). They disperse widely in both coastal waters and in the Gulf of Alaska and eastern North Pacific Ocean (including the Bering Sea) to as far south as 40°N at least (Godfrey et al. 1975). Tag recoveries have shown that juvenile coho salmon that originate in streams tributary to the Bering Sea penetrate into waters south of Adak Island in the North Pacific Ocean at least as far west as 176°51'W (ibid.) and at least as far south as 45°24'N (Harris and Myers 1983). Coho salmon of Western Alaska origin (e.g., Yukon River and Kuskokwim River drainages) are also known to enter the central Gulf of Alaska to at least as far east as 145°W and well to the south of 50°N (Godfrey et al. 1975).

During early spring and summer, as surface water temperatures warm, North American coho salmon begin a generally northly movement. There is not yet sufficient information that would indicate clearly from what locations or at what times the continued migrations of particular stocks become more positively directed toward home streams. Tagging data do suggest, however, that this does happen - that is, that a general northward movement over a broad east-west front of many mixed stocks changes to migrations by individual stocks or particular groups of stocks that vary in relation to the locations (and probably distances also) of their ultimate destinations (ibid.).

VII. FACTORS INFLUENCING POPULATIONS

A. Natural

Scott and Crossman (1973) state that "coho juveniles especially when aggregated and abundant, are preyed on by a variety of fishes (e.g., coho salmon smolts, cutthroat and rainbow trout, Dolly Varden, and sculpins), mergansers, loons, kingfishers, other birds, and some small mammals. The adults during their spawning run are taken by bears, other mammals, and large birds. In the ocean, lampreys, and aquatic mammals (e.g., seals and killer whales) are the chief predators."

The greatest natural mortality occurs in fresh water during the early life stages and is greatly influenced by environment (Straty 1981); therefore, deleterious changes in the freshwater quality, quantity, or substrate are most detrimental.

B. Human-related

A summary of possible impacts from human-related activities includes the following:

- Alteration of preferred water temperature, pH, dissolved oxygen, and chemical composition
- Alteration of preferred water volocity and depth
- Alteration of preferred stream morphology
- Increase in suspended organic or mineral material
- Increase in sedimentation and reduction in permeability of substrate
- Reduction in food supply
- Reduction in protective cover (e.g., overhanging stream banks or vegetation)
- Shock waves in aquatic environment
- Human harvest

(For additional impacts information, see the Impacts of Land and Water Use volume of this series.)

VIII. LEGAL STATUS

A. Managerial Authority

1. The Alaska Board of Fisheries develops regulations governing the commercial, sport, and subsistence harvest of salmon in Alaska. The Alaska Department of Fish and Game manages salmon populations in the fresh waters of the state and in the marine waters to the 3-mi limit.
2. The North Pacific Fishery Management Council is composed of 15 members, 11 voting and 4 nonvoting members. The 11 are divided as follows: 5 from Alaska, 3 from Washington, and 3 from state fishery agencies (Alaska, Washington, Oregon). The four nonvoting members include the director of the Pacific Marine Fisheries Commission, the director of the U.S. Fish and Wildlife Service, the commander of the 17th Coast

Guard District, and a representative from the U.S. Department of State.

The council prepares fishery management plans, which become law and apply to marine areas between the 3-mi limit and the 200-mi limit. With regard to salmon, the only plan prepared to date is the Salmon Power Troll Fishery Management Plan.

3. The International North Pacific Fisheries Commission (INPFC), a convention comprised of Canada, Japan, and the United States, has been established to provide for scientific studies and for coordinating the collection, exchange, and analysis of scientific data regarding anadromous species.

   With regard to salmon, the INPFC has also prepared conservation measures that limit the location, time, and number of fishing days that designated high seas (beyond the 200-mi limit) areas may be fished by Japanese nationals and fishing vessels.

IX. LIMITATIONS OF INFORMATION

Very little life history and habitat information concerning Alaskan coho salmon has been documented. Most of the available information comes from Pacific Northwest and Canadian field and laboratory studies.

X. SPECIAL CONSIDERATIONS

Caution must be used when extending information from one stock of coho salmon to another stock. Environmental conditions for one area must not be treated as absolute; the stocks (races) have acclimated or evolved over time and space to habitat conditions that can vary greatly.

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